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SYNOPSIS OF THE AMERICAN SPECIES OF THE GENUS PAPIRIUS.

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INTRODUCTION.

Every student of Entomology in pursuing his favorite subject is bound to find certain difficulties to be overcome. Some insects have very fragile bodies, while others have minute hairs and spines which are of value for classification, and must therefore be protected. Still other insects may be very hard to locate or capture without injury.

Nearly all of the above difficulties must be overcome by a student of the Thysanura. This is especially true of very minute fragile forms, as the *Aphoruridae*. While the number of specimens of Collembola collected in one day may be considerable, yet the greater majority will be found to belong to one or two species of the genus *Tomocerus*, which are very common everywhere. To secure the more rare forms requires long and careful searching, especially the genera which have such admirable color protection as we find in the genus *Papirius*.

This genus contains one or two rather widely distributed species which are quite common in places, but the remainder of the species described for America are extremely rare or limited in their range, at least we find but a small amount of literature on the species of this genus. One explanation of this is in the fact that many of the original descriptions are so brief that it would be almost impossible to identify specimens from them, even if the literature were accessible, which is frequently not the case.

It is to partially obviate this last difficulty that the present paper has been compiled, giving a brief synopsis of all known

work on our American *Papirius*. While the genus is of very little economical importance, yet it holds a unique position with respect to the other Thysanura, and to the insects in general.

It is the intention to use this paper as a foundation for future work along systematic and phylogenetic lines.

Characters of the Genus.

The characters which separate our apterous, or primitive wingless insects, into the principal groups or sub-groups are, as a rule, fairly well defined. The first attempt at classifying our apterous fauna was made by Linnaeus in 1746, when he placed all the springtails (*Collembola*) in the genus *Podura*.

In 1796 these were combined by Latreille with the genus *Lepisma* and elevated to the rank of an order under the name Thysanura. He distinguished two genera of the *Lepismidae* and two of *Poduridae*, separating out the globular shaped species under the name *Smynthurus*. This term is now used to distinguish the family whose characteristics may be defined as follows: Body globular, slightly longer than broad; the saltatorial organ present, attached to the penultimate abdominal segment; and provided with a ventral sucker.

This family, *Smynthuridae*, varies considerably from all the other groups of apterous insects in having a round, almost globular body. The antennae are very much knobbed, and consist of four segments, with the exception of the genus described by Bourlet, which he termed *Dicyrtoma*, having eight jointed antennae. However, some doubt the validity of this genus since the characters are very doubtful as the knobbed, four jointed antennae of *Papirius* might easily be mistaken for an eight-jointed one, nevertheless this genus will here be retained.

The family, *Smynthuridae*, is divided into three genera which are very closely allied and separated entirely on antennal characters as follows:

A. Terminal segment of antennae short, with whorls of haris. *Papirius*.

AA. Terminal segment of antennae long, annulated.

B. Antennae with eight segments, abdomen with two tubercles. *Dicyrtoma*.

BB. Antennae with four segments, abdomen without tubercles. *Smynthurus*.

The genus *Papirius* is distinguished by only one character, that of having a short terminal segment to the antennae with whorls of hairs, and being considerably annulated. The genus was proposed by Lubbock in 1872, having *Podura fusca* Geoffrey, as its type, and characterized by Lubbock as follows: "Body globular, antennae four-jointed, terminal segment short with whorls of hairs. Saltatory appendage comopsed of a basal portion and two arms."

However, MacGillvray in The Canadian Entomologist, Vol. XXV, gives some further characters which are of value in separating *Smynthurus* from *Papirius*. His characterization is as follows:

A. Terminal segment of antennae long, ringed; larger claw unindentate; apical segment of spring simple. *Smynthurus.*

B. Terminal segment of antennae short; with whorls of hairs; larger claw bidentate; apical segment of spring serrate on the under side. *Papirius.*

Of the general characters of the family, *Papirius* possesses most of them. The antennae are long and slender, and often distinctly annulated; however these annulations have been the source of not a little confusion of the genus with *Smynthurus;* many investigators failing to see the division between the third and fourth segment. Still by careful examination there may always be found a distinct line separating the two joints.

The legs are generally long, the larger claw bearing two or more teeth. The spring is very long, and well adapted for leaping; the dentes and mucrones in most cases being serrated.

The ventral sucker is highly developed, and on agitating the insect it may be seen to throw out the long tactile filaments from the sucker.

The segments of the globular abdomen are fused; only the terminal segment being distinct. Dorsal tubercles are present in some species and also tenant hairs. The eyes are distinctly black, with prominent ocelli. The head in all species is loosely joined to the body.

The one characteristic of *Papirius* which distinguishes it from *Smynthurus* and *Dicyrtoma* is the four-jointed antennae, with the short terminal segment. *Smynthurus* has a four-jointed antennae, but the fourth segment is long, while *Dicyrtoma* has an eight jointed antennae. This character of the short terminal segment in *Papirius* is marked enough to make it quite a distinct genus.

General Anatomy.

The general plan of structure of this genus does not differ materially from that of other insects, and with the exception of the terminal joint of the antennae does not differ at all from the type of the family.

The Body, as in all *Smynthuridae*, is globular in shape, and the abdomen consists of six segments, the average length of the entire animal being about 1 mm. The shape of the body may vary to oval as in *novoeboracensis*, or sub-triangular as in *texensis*, while *unicolor* has a slightly reentering angle at the terminal segment.

The Head, is about as long as broad, and joined loosely to the body. On its upper surface are the black eyespots. These

differ considerably from the general type of insects' eyes in consisting of a smooth elevated area with very sharp, definite outline; this area being termed the eye spot. Arranged in two or more distinct rows on each eyespot are the true eyes or ocelli. These are entirely separate and function as do the simple ocelli in the higher insects. Eight ocelli are found in each eye spot, varying in size in the same species.

THE ANTENNAE. Immediately in front of the eyes are the long, slender antennae, the terminal segment of which is but little longer than the basal segment, and conical in shape. Both the third and fourth joints bearing whorls of hairs and one or both are often annulated, as in *marmoratus*, while the third joint is composed of sixteen sub-joints; in *unicolor* the third joint has seven or eight sub-joints, and the terminal segment about ten; and in *olympius* the terminal joint has seven sub-joints. As to the other sepcies we can not say, the descriptions being too brief.

THE MOUTH PARTS, are more or less withdrawn within the head and are intermediate between the true mandibular insects, and those with mouth parts adapted for sucking. The upper and lower lip appear as small, flattened, almost scale-like structures, while only the tip of the maxillae and mandibles are visible. These organs are much elongated and together with the hypopharynx may be used to rasp off particles of decayed vegetation upon which the animal feeds.

THE THORAX, as in all insects, consists of three segments, pro, meso, and meta thorax, each bearing a pair of legs. In this genus the segments of the thorax, especially the first one is greatly reduced and partially covered by the protrusion of the second segment of the thorax. As a usual thing the legs are long, slender, and covered with hairs or spines. Two claws are always present, a larger and a smaller one; the concave edges facing one another, and the larger one curved around the end of the smaller one. Small teeth may be found in various numbers on these claws; the larger claw in *texensis* and *marmoratus* bearing three teeth, while in the remainder of the species it has two, except in *novoeboracensis* of which we have no knowledge. The smaller claw is found either dilated, as in *texensis*, bearing one tooth as in *maculosus* and *unicolor*, or hairy as in *olympius* and *purpurescens*. Tenant hairs are mentioned only for *purpurescens*.

THE ABDOMEN, as before stated, consists of six segments, which with the exception of the terminal one are fused, and from the dorsal side can not be distinguished. On this account the abdomen presents a smooth even surface, sparselv covered with hairs, and never bearing scales, as is common with so many *Thysanura*. Packard's *marmoratus* is mentioned as having two pale, smooth tubercles on each side of the basal, abdominal segment and MacGillvray's *purpurescens* an anal tubercle; however,

there are none mentioned for any of the other species. On next to the last abdominal segment is an organ peculiar to the *Collembola*. This is known as the spring or furcula. It consists of four parts, as follows: attached to the abdomen is a broad, almost triangular piece, we may term the basal plate. This is covered with hairs, and forms the basal part of the spring. Attached to the anterior border of this basal plate are a couple of broad flattened pieces known as the manubrium. In some genera these are fused, but we find them separate in *Papirius*. Joined to the anterior end of the manubrium are the dentes. These are long and pointed and very characteristic, usually having an inner serrated edge, and numerous characteristic hairs or spines. At the end of the dentes we find a tooth-like structure known as the mucrones. These are also serrated and very characteristic. This entire organ is nearly as long as the body. On the second or third abdominal segment is an organ known as the catch or tenaculum. This consists of a basal portion and two short arms. The entire organ is small and difficult to see and may possibly hold the spring in position. On the first abdominal segment is an organ known as the ventral sucker. This is a short tube attached at one end and free at the other. From the free end may be protruded two long filaments, nearly as long as the body. These are covered with a large number of glands which secrete a sticky substance. By means of these filaments the insect may hold fast to smooth objects, or right itself, if placed on its back.

Habitat.

These interesting little insects may be found in numerous dark, shady nooks; under decayed wood and leaves in the woods; and always where there is some moisture, though not an excess of water. They remain quiet until disturbed, or exposed to a strong light when they prove themselves most agile in their movements. My experience has been to find them more on the under surface of chunks of decayed wood lying about in moist and damp situations than under bark. I have also taken them in numbers under stones along river banks, though never on the water where some of the *Smynthurus* are found. A most favorable time to collect *Papirius* seems to be on a warm day, just after a little very cold weather. They seem not to have thoroughly warmed up yet, and may be captured in vials quite easily by placing the vial near them and urging them on slightly by means of a small brush. They may be successfully bred in the laboratory in vials by giving them plenty of moist decayed wood and leaves to live on. These vials should be kept in the dark, giving the insects so nearly as possible their natural condition. I have tried this experiment in the case of *unicolor* and

find it most practical. As it grows colder in the fall the insects decrease in numbers. However, I have taken *P. unicolor* as late as December 13th in a comparatively open area, and after considerable cold weather and two or three snows. I do not doubt that they could be taken throughout the winter in the more protected places.

These insects are quite gregarious in their habits, and usually associate in colonies of from four or five to a dozen or more. They are very well protected by their color, which is usually of a reddish tinge in correspondence to the brown decaying wood on which they are usually found.

Life History.

So far as is known the eggs of *Papirius* have never as yet been observed, with the exception of *P. pini* Folsom. In connection with this I would note an experience in an attempt to solve the problem. Late in the fall some large forms of *Papirius* were placed in a vial containing damp decaying wood, and watched very closely. In about two weeks two colonies of young ones were observed, but in the meantime there had been no trace of any eggs, which might easily lead one to believe the eggs are very minute in some species.

In appearance these young are lighter in color than the adults having more of a blue tinge than the brownish-purple adults. All their organs were perfectly formed, the antennae, however, being somewhat longer in proportion to the body than in the adult. Apparently these young are quite as active as their parents in their movements. With each successive moult they grow darker and take on more the color of the adult.

Bibliography.

1821. Say, Thomas.—Journal of the Academy of Natural Science of Philadelphia. Vol. 2. In a paper entitled, "Description of the Thysanura of the United States." (Read Nov. 21, 1820). Say describes but one species of Papirius under the name of *Smynthurus guttatus*..... Pg.13.

1859. Le Conte, John L.—The complete writings of Thomas Say on the Entomology of North America. Vol. 2. A reprint of Say's work. *Smynthurus guttatus*.....Pg. 8.

1862. Fitch, Asa.—Eighth Report on Noxious and Other Insects of New York. The description of several Thyranura including *Smynthurus novoeboracensis*..... Pg. 674.

1873. Packard, A. S.—Report of the Peabody Academy of Arts and Science. In the appendix to the director's report under the title, "Synopsis of the Thysanura of Essex County of Mass., with description of a few extratimital Forms." Packard reviews the literature on American species and mentions the following

species of Papirius: *Smynthurus guttatus* Say, Pg. 25; *S. novoeboracensis* Fitch, Pg. 25; *Papirius marmoratus* Packard, Pa. 42; *P. texensis* Packard, Pg. 42.

1891. SCHÖTT, H.—Beitrage zur Kenntnis Kalifornischer Collembola in: Bihang Sevensk. Vetensk-Akad. Handl. 17. Afd. 4. N8. Pg. 25.

A paper describing a number of Thysanura from California, including *Papiurius maculosus* Schött.

1893. MACGILLVRAY, ALEX D.—North American Thysanura. Fifth paper in The Canadian Entomologist. Vol. 26. A systematic work on the Thysanura of North America. *Papirius olympius* MacGill., Pg. 110; *P. purpurescens* MacGill., Pg. 109.

1893. HARVEY, F. L.—A new Papiruis in Entomological News. Vol. 4. This paper consists of a minute description of one species, with a critical review of the literature on *Smynthurus* and *Papirius*. *Papirius unicolor* Harvey, Pg. 65; *Smynthurus novoeboracensis* Fitch, Pg. 65; *S. marmoratus* Packard, Pg. 65.

1895. DALLATORRE, K. W. V.—Die Gattungen und Arten der Apterygogenea. This consists of a key to the genera, list of the described species of the world and bibliography. He includes in the genus Papirius the following American species, Pg. 9: P*apirius guttatus* Say; *P. maculosus* Schött; *P. marmoratus* Packard; *P. novoeboracensis* Fitch; *P. olympius* MacGill.; *P. purpurescens* MacGill.; *P. texensis* Packard; *P. unicolor* Harvey.

1903. GUTHRIE, JOSEPH E.—The Collembola of Minnesota. A descriptive catalogue of the species of the state, including: *Papirius maculosus* Schött, Pg. 58; *P. unicolor* Harvey, Pg. 59;

1896. FOLSOM, J. W.—"New Species of Papiruis," in Psyche Vol. 7. In this paper Folsom describes three new species of Papirius all taken at Arlington, Mass., in 1895. *Papirius hagenii* Folsom, Pg. 344; *P. pini* Folsom, Pg. 344; *P. testudineatus* Folsom, Pg. 345.

1896. FOLSOM, J. W.—"Notes on the Types of P. texensis Pack. and Description of a new Smynthurus." In Psyche, Vol. 7. Redescribes Packard's species: *Papirius texensis* Packard, Pg. 384.

1896. FOLSOM, J. W.—"Two New Species of Papirius," in Canadian Entomologist, Vol. 28, May. The paper describes two new species of Papirius taken in a greenhouse at Cambridge, Mass.: *Papirius vittatus* Folsom, Pg. 119; *P. opalinus* Folsom, Pg. 120.

CHARACTERIZATION OF SPECIES.

The characters given for many of these species are so brief that it would be useless to try to form a key. Therefore we will give in summary what, from the descriptions, seems to be the chief characteristics.

1. **Papirius guttatus** (Say).

1821. *Smynthurus guttatus* Say.
1859. *Smynthurus guttatus* LeConte.
1873. *Papirius guttatus* Packard.
1895. *Papirius guttatus* Dalla Torre.

Prevailing color, yellowish-white. Head maculated. Antennae, reddish-brown, hairy. Eyes black. Body, yellowish-white with numerous irregular spots disposed in bands; numerous sparse, white hairs; two tubercles each side of the middle of the body which are truncated at the tip; ventral part of body white. Spring, flesh colored. Length, 1.3 mm. Habits, "found under the bark of the long-leaved pine (P. palustris) in Georgia."

The chief characteristics of this species as given by Say, seem to be a prevailing color of yellowish-white with numerous, irregular, reddish-brown spots. Neither MacGillvray nor Harvey have reported this species, and thus far we have only the original description. Perhaps this may be accounted for by the fact that it is a southern form, and probably with a restricted habit, since Say only mentions having found it under the bark of the long-leaved pine. The description is so very brief it would be hard to identify a specimen by it. *P. guttatus* is placed in this genus on account of the tubercles which are not found in the genus Smynthurus.

2. **Papirius novoeboracensis** (Fitch.)

1862. *Smynthurus novoeboracensis* Fitch.
1873. *Papirius novoeboracensis* Packard.
1893. *Papirius novoeboreacensis* Harvey.
1895. *Papirius novoeboracensis* DallaTorre.

Prevailing color, dull brownish-yellow. Head pale. Antennae nearly the length of the body, long and slender. Eyes black. Body but little broader than head, oval, slightly attenuated at its tip, with an impressed, transverse line conspicuously separating the apex from the body. Legs light yellowish-brown in color. Length about 2 mm. Habits under rubbish and boards.

The chief characters, as given by Fitch, which distinguishes this species, as a *Papirius* is, as he says, "the length beyond the elbow of the antennae being obscurely divided into three joints." This point was definitely settled by Harvey who examined the type specimens and said that Fitch in his work had overlooked

the short end joint which would classify it as a *Papirius*. This species is quite akin to *unicolor* with which it almost agrees in size and habit, differing in color and form of antennae.

3. **Papirius marmoratus** Packard.

1873. *Papirius marmoratus* Packard.
1893. *Papirius marmoratus* Harvey.
1895. *Papirius marmoratus* DallaTorre.

Prevailing color deep, dull lilac, with pearly colored lines and spots. Head large, free from body, swollen on the sides and over the clypeal region. Antennae dull lilac, paler on basal half, terminal half of third joint divided into sixteen sub-joints, much swollen, fourth joint rather long, annulated. Eyes black. Body marbled over with deep, dull lilac, and pearly colored lines and spots, a median dorsal, pearly streak along the basal half of the abdomen, beneath light, pearly, marbled with lilac; elongate oval in form with two pale, smooth tubercles on each side of the middle of the first abdominal segment, the two following segments narrow, and projecting far out like a fungoid growth. Legs dull lake, femur pearly at base and end; tibia alternate light and dark lilac; claws, superior one with four teeth, obscure. Furcula pale lilac, in the young whitish; dentes serrulate beneath; mucrones long and slender, oval at tip. Length 2.5 mm. Habits, "on toad stools, abundant at Brunswick, Maine, Sept. 10, and Woods Hole, Mass., Sept. 15, (Packard); vicinity of Boston (Sanborn)."

"This fine marbled species may be known by its decided lilac hue, and meidan pale line, as well as the two pale dorsal tubercles and its large size." (Packard). Fifteen type specimens deposited in the museum of Comparative Zoology.

4. **Papirius texensis** Packard.

1873. *Papirius texensis* Packard.
1895. *Papirius texensis* DallaTorre.
1896. *Papirius texensis* Folsom.

Prevailing color pale luteous, marbled with brown and black. Head paler, a few short bristles above the mouth and on the posterior dorsum; long stout hairs on the vertex and anterior dorsum. Antennae shorter than body, pale reddish-brown, growing darker toward the end; segments nearly as 1:5:5:2; basal segment twice as long as broad, naked; second sub-petiolate, sparsely hairy; third petiolate, hairy with ten distinct sub-segments, the penultimate one laterally-dilated, fourth segment lanceolate. Eyes black. Legs long, slender, tibia with broad, alternate light and dark bands. Claws; superior one, long and slender, little curved, obscurely toothed; inner edge sinuate basally, toothed in the middle and obscurely beyond. Two teeth on either side

near the outer edge dividing it into thirds; inferior claw two-thirds as long as superior, stout and tapering, with a short bristle inside upon a rounded basal dilation, and with a sub-apical bristle exceeding the other claw in length; tenant hairs absent. Furcula nearly reaching the mouth, manubrium with a few ventral hairs; dentes tapering with remarkably long and large lateral hairs, barbellate basally, and four long equidistant ventral hairs; mucrones one-fourth length of dentes, laterally linear, little tapering, serrulate beneath, apex with three rounded lobes bent downward. Length 1.3 mm. (Folsom-Packard). Habitat, "Waco, Texas."

"Very closely allied to *P. marmoratus*, but is more hairy, the body more finely marbled appearing as if tuberculated, while the skin of *P. marmoratus* is smooth; it also wants the two, pale, smooth tubercles on the body of the latter." (Packard.) The type specimens were redescribed by Folsom who stated that "The tube containing them was found to hold not only fourteen specimens of a *Papirius*, but also ten examples of a *Smynthurus*, and the original description of *P. texensis* evidently combines the characters of both these species which certainly do resemble each other superficially." Type specimens in the museum of Comparative Zoology.

5. **Papirius maculosus** Schött.

1891. *Papirius maculosus* Schött.
1895. *Papirius maculosus* DallaTorre.
1903. *Papirius maculosus* Guthrie.

Prevailing color, a whitish-ground color sometimes varying to a yellowish or grayish tone, almost the entire upper part of the body showing dark, blue spots of various forms which often vary to a sky blue; clear white on ventral side. Antennae dark blue; shorter than body. Legs with distal half of tibia white. Claws; superior claw armed with two teeth, inferior claw with a single perpendicular tooth. Furcula pale violet; manubrium short; dentes about three times as long as mucrones, bearing two distinct kinds of hairs, simple, and pinnate or notched, regularly arranged, two pairs of notched hairs being between two simple hairs, the most distal of the simple hairs reach almost to the mucrones. Length, 1.5 mm.

This species seems to have a rather wide range. Guthrie reports it abundant in Minnesota, and the original description was taken from specimens collected in California. The species seems very closely allied to *P. marmoratus*, and according to Guthrie, may be a variety of this species. The color seems to be somewhat lighter, with slight variations in markings.

6. **Papirius unicolor** Harvey. Plates XI and XII.

1893. *Papirius unicolor* Harvey.
1895. *Papirius unicolor* DallaTorre.
1903. *Papirius unicolor* Guthrie.

Prevailing color light brownish-purple throughout, color much like that of a Delaware grape; back, end of legs, and apical half of the antennae darker; dorsum often with two interrupted stripes of darker shading, head, base of antennae, base of legs, spring and ventral surface lighter; young, half grown specimens, and full grown specimens in damp situations paler; occasionally a very large specimen and those taken in dry places are more brown, but all show the purple tint. Sides of full grown specimens often obscruely marked with pale oblong spots. Head viewed from front as long as broad, depth half the length; elevated between the eyes and bearing a tuft of long hairs. Antennae long, slender, elbowed at the second joint, nearly as long as the body; basal joint short but slightly longer than the terminal one; second joint shorter than third, the portion beyond the elbow usually somewhat longer than the two basal joints; third joint usually the longest, the terminal half composed of seven or eight sub-segments; terminal joint short, conical, narrower than the club-shaped end of the third joint; composed of about ten sub-segments, the three basal of which are about the same length, and obscure, fourth and fifth wider and well defined, sixth and seventh narrower and somewhat obscure; each segment bears a whorl of hairs, and as there are three whorls on the portion below the seventh segment probably it represents three more joints; when walking the basal joint of the antennae is projected upward and outward from the head; the apical portion beyond the elbow outward and downward. Eye patches prominent, elevated, black, bearing eight ocelli, four in the inner row, three in the outer with a single small one in the midlde; the second ocellus from the front in the inner row is also smaller than the others. 'Body, including head, twice as long as broad, breadth and depth equal, gradually widening from the neck to the greatest width, abruptly narrowing with a slight re-entering angle to the conspicuous terminal segment. Legs long. Claws prominent; larger curved and bearing two teeth on its inner face, below the middle; smaller claw slender, over half the length of the other with a small tooth on its inner surface. Furcula rather long and slender from about three-fourths to longer than body; mucrones less than half the length of dentes, lanceolate, unarmed, concave below and bearing on each edge of the concavity a row of about forty teeth,which increase in size outward and at the end join in a common tubercle; dentes long, slender, covered with hairs. Ventral sucker short, cylindrical, tactile filaments white, covered with papillae, nearly as long as body.

Length 1.9 mm.; head .8 mm. long, .8 mm. broad, .4 mm. deep from front to back; antennae 1.7 mm. long, joints in the ratio of 7:22:25:6; body 1.6 mm. long, .8 mm. broad, .9 mm. deep; spring 1.6 long, segments in the ratio of 5:6:2; sucker, including filaments, 1.5 mm. long. Habits, found in numerous localities, under decaying wood, under damp stones, or boards, and occasionally found on various species of fungus.

This is one of the most common and widely distributed species of the genus. I have found it quite abundantly in Ohio, and it has been reported as abundant in Maine by Harvey who found it associated with *P. marmoratus* on Agarics and Boleti, and has also been reported from Minnesota by Guthrie. I have taken it in mid-winter in Ohio, where it occurs in small colonies in suitable localities. The very young have a decidedly bluish tint, but otherwise resemble the adults very closely. They are sluggish in their movements, but when disturbed can jump eight or ten inches. Harvey states that the smaller claw is over a half the length of the larger; however, in all the specimens I have examined a long-hair-like projection extends beyond the end of the larger claw.

7. **Papirius olympius** MacGillvray.

1893. *Papirius olympius* MacGillvray.
1895. *Papirius olympius* DallaTorre.

Prevailing color reddish, spotted with dark brown, in young specimens purplish. Head, vertex covered with stiff bristles; a longitudional brown band extending from the back of the head to the eye spot, another in the middle of the vertex extending down the middle of the front. Antennae nearly as long as the body, purplish, hairy, basal segment light at base, dark at apex and one-fourth the length of the second; second segment one-half the length of the third, third segment slender, with seven sub-segments at apex; fourth segment with six sub-segments. Eye spot black. Abdomen and thorax with two sinuate brown bands on each side of the dorsum, the middle ones meeting at the apex and base of the thorax and on the basal half of the abdomen; also a band extending from this basal transverse band of the abdomen along the middle of the back towards the head bilobed in front, a triangular spot just before the apex of the abdomen, and promiscuous brown mottlings on the side; body covered with broad flattened hairs. Legs reddish, long, slender, spiny. Claws long, outer three times as long as the tibia is broad, with two teeth; inner two-thirds the length of outer, with a hair at apex reaching beyond the apex of the outer claw; tenant hair wanting. Furcula long, slender; manubrium short, two-thirds the length of dentes; dentes with a row of long, hair-like spines along the side of each member; mucrones about one-fourth the length of dentes, serrate beneath.

Length 2–3 mm. "Habitat, Olympia, Washington."

Apparently MacGillvray is the sole collector of this species in America so far, at least we have no record given of it by any one else.

8. **Papirius purpurescens** MacGillvray.

1893. *Papirius purpurescens* MacGillvray.
1895. *Papirius purpurescens* DallaTorre.

Prevailing color, blackish purple. Head between the antennae washed with yellow. Basal segment of the antennae very short, one-third the length of the second; second segment white or transparent. Body, dark purple; abdomen slightly hairy, the hairs more abundant at the posterior end; last segment fringed with clavate hairs. Legs long, slender, hairy. Claws short, stout; superior claw with two teeth, one at the middle, the other at the base; inferior claw nearly as long as the superior, more slender with two bristles at the tip; tenant hairs present. Furcula dark purple, long, slightly hairy above; dentes half the length the manubrium, narrowed beyond the base; mucrones one-fourth the length the dentes; apex blunt, serrated at the middle. Length 3 mm. Has been reported only from Long Island.

This is one of the largest species of *Papirius*, and has never been reported except by MacGillvray.

9. **Papirius hagenii** Folsom.

1896. *Papirius hagenii* Folsom.

Prevailing color, yellowish-orange with purple markings. Head translucent, orange ochraceous, orange around the mouth, a few stiff bristles upon the vertex and face. Antennae nearly as long as body, orange, becoming purplish on the last few segments; basal segment naked; second four times as long as the first; a few hairs distally; third equalling second plus one-half of first, verticillate; terminal segment twice as long as basal, with whorls of hairs, as is common to the genus. Eyes black. Body, thorax yellow, abdomen oval in dorsal aspect, dark purple, almost black covering the sides and pale ventral surface with a well defined but zigzag margin; a yellowish-brown pattern on posterior half of dorsum very variable in shape, usually consisting of five elongate markings which may or may not be united; posterior part of abdomen with a few short, white bristles, longer on the terminal segment. Legs yellow, paler at base; tibia spiny. Claws transparent, slender, rather straight, little curved inside; superior claw with a sharp tooth inside one-third distant from apex; second tooth obscure, in the middle; inferior claw two-thirds the length of superior, with one stout knobbed tenant hair, twice as long fixed on its inner side, except at its tip which is free. Furcula long, extending to mouth, stout, pale yellow

at base, becoming white distally; manubrium over one-third the dentes in length; dentes three times the mucrones, each dentes with a row of long spines on either side; mucrones cylindrical, apex rounded, minutely serrated beneath, ventral abdominal surface with an oval, yellow swelling either side of the manubrium, and two similar but much larger ones placed obliquely and anteriorly. Length 1.3 mm.; maximum 1.5 mm. Habits: reported by Folsom as occurring as an active, uncommon species, in pine woods, under damp decaying twigs and needles, Arlington, Mass.

10. **Papirius pini** Folsom.

1896. *Papirius pini* Folsom.

Prevailing color, chestnut-brown. Head pale, a few short stiff bristles upon a protrubence on the vertex, and down sides of the face. Antennae four-fifths the length of body; basal segment stout, naked; second four times as long with a few long hairs distally; third equalling the first two with distal half; divided into seven distinct sub-segments, and three others less evident swollen terminal ones; each sub-segment with a pair of hairs, a few hairs near the base of the third joint; fourth segment equalling basal in length, with whorls of long hairs. Eyes black. Body, abdomen ovate dorsally, dilated at sides; dorsum darker with several long, white bristles anteriorly, and very short bristles posteriorly; anal tubercle with long, stout bristles. Legs long, slender ,spiny, especially on tibia. Claws, superior one long, rather straight, a sharp tooth in the middle, and another midway between it and the tip, a third tooth on the outside nearly opposite the last; inferior claw with straight, tapering sides, and an apical hair hardly longer than the other claw; the extreme tip of the claw free from the hair. On the inside of the inferior claw, near the base is a dilation whose apex bears a short bristle. Furcula pale, extending beyond the ventral tube; manubrium stout; each dentes with a row of long spines on either side; mucrones tapering, one-third the length of dentes, coarsely serrated beneath. Length 1.6 mm. Habits, reported by Folsom as living on the under side of pine logs, and eating the wet decayed wood.

This species has been reported only by Folsom from Arlington, Mass., the description being taken from twelve specimens found during October and November. Concerning the habits the author further says, "The last specimens found before a severe frost were all females which laid numerous eggs in captivity when given natural conditions of moist food, air and darkness. The eggs, laid singly, were spherical, with strongly flattened ases, translucent white, smooth, .3 mm. in diameter, .15 mm. igh, and with embryos quite undeveloped several days after epo sition."

11. **Papirius Testudineatus** Folsom.

1896. *Papirius testudineatus* Folsom.

Prevailing color, dark purple, almost black with conspicuous wax yellow patterns. Head large, face with large markings and a few short bristles; vertex with a few long bristles, and a stirrup shaped marking in the middle; behind this a long, broken, transverse band. Antennae, .7 the length of body, purplish; basal segment twice as thick as second; second five times as long as first, somewhat petiolate with a few hairs; third equalling first two, slightly petiolate, gradually forming sub-segments distally, the first seven of which are distinct, and the three distal ones much swollen, especially the penultimate one; terminal segment equal to basal in length; third and fourth segments with whorls of long hair. Eyes black. Body, abdomen ovate dorsally, with a large pattern composed principally of thick median, longitudional and oblique bars; dorsum with a few long bristles anteriorly, many short ones posteriorly; sides with large, elongate spots; anal tubercle large, with several large spots, and many stiff bristles. Legs very long, slender, hairy, with broad, alternate bands of purple and yellow, except on the tibia. Superior claw long, of rather uniform width, bent only towards the tip, divided on the inside nearly into thirds by two prominent teeth; inferior claw half as long, conical in shape, apparently prolonged into a bristle; a short bristle on inside of inferior claw at its base. Furcula long, nearly reaching mouth, purplish; each dentes with a row of long spines on either side; mucrones white, cylindrical; apex rounded, one-third the length of dentes, serrated beneath. Length 2.2 mm.

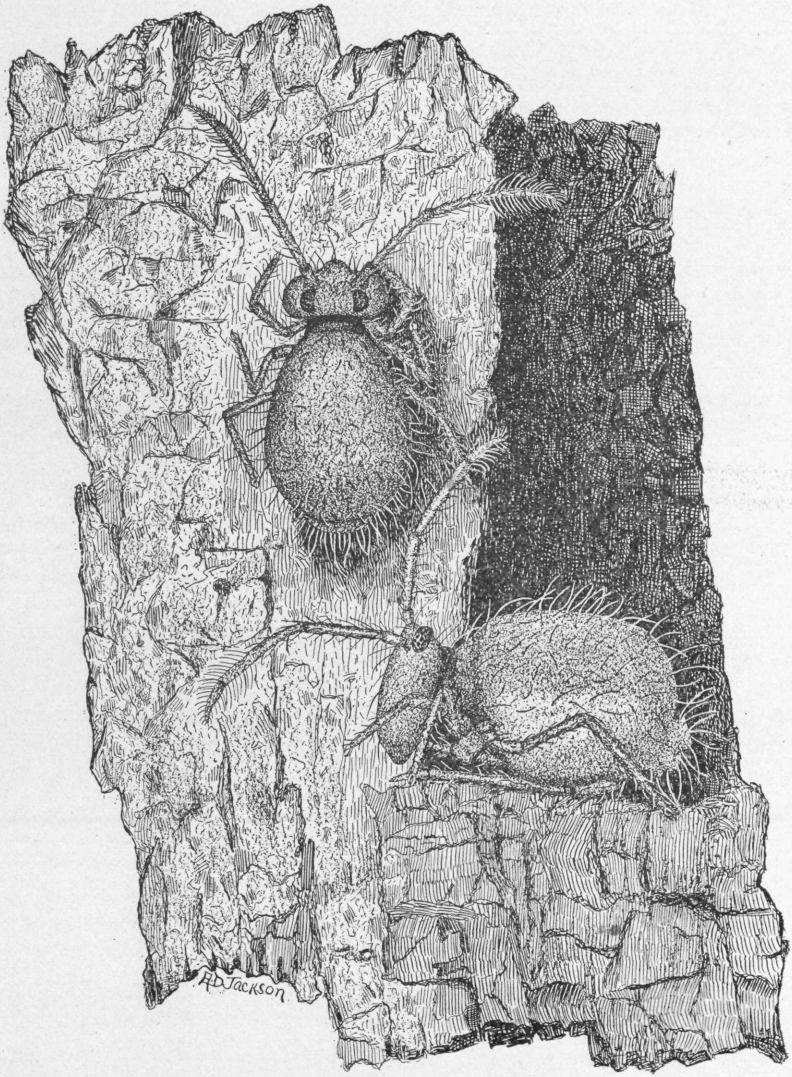
The description was taken from four specimens which were deposited by Mr. Folsom in the Cambridge Museum of Comparative Zoology.

12. **Papirius vittatus** Folsom.

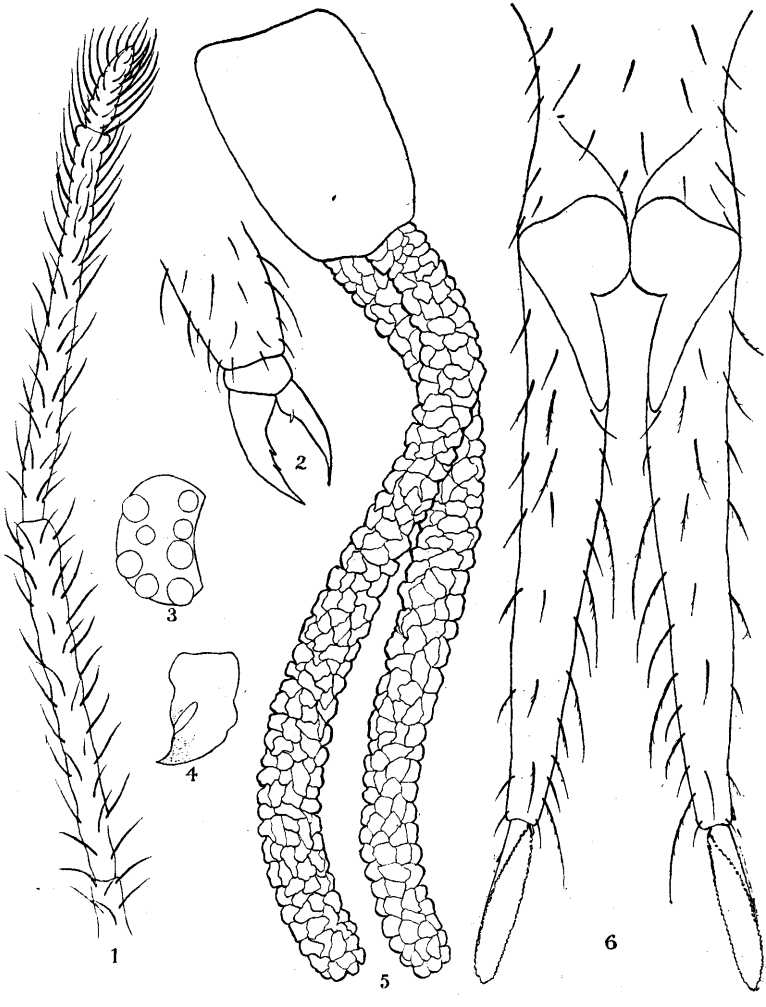
1896. *Papirius vittatus* Folsom.

Prevailing color, young specimens dark purple above with pearly markings, lavender or lilac beneath; older ones maroon to almost black above, sides mottled with several shades of purple and brown. Head free, purple with a broad transverse band across the front, oral region whitish, vertex with a distinct white sagittal mark from antennae to pro-thorax; black ocelli-like effect on the middle of the vertex; a few short bristles upon the vertex in front. Antennae longer than the body, except in large individuals; segments variable in relative length, but approximately in the ratio of 1:6:7:1.5, or 1:7:9:2; basal segment short, as long as broad, brownish with short white bristles, the remainder of the segments sparsely haired, the third with five to seven sub-segments with whorls of hairs. Eyes dark, close behind the

OHIO NATURALIST. *Plate XI.*



JACKSON on "American Species of Papirius."



JACKSON on "American Species of Papirius."

antennae upon a black patch with a narrow border of purple. Body, ovate dorsally with a re-entering angle; dorsum dark purple to black with a pattern in pearly white essentially as follows: on anterior half of dorsum a median longitudional purplish streak between two pearly streaks with dentate margins; behind these a square purple spot bounded by pearly and bisected by a short median, longitudional, pearly streak; on either side two short irregular pearly lobes extending obliquely forward; next behind on the median line are one to three roundish purple spots broadly surrounded by pearly white; on posterior abdomen a long, oblique, pearly bar directed forward from either side of the median line; abdomen with a small pale tubercle on either side of the middle; dorsum naked anteriorly with short white bristles posteriorly; anal tubercle with bristles four times as long and with a median longitudional purple bar; sides purple to blackish, with conspicuous, hazel, chestnut and cinnamon mottlings: thorax with a broad, lateral longitudional, pearly band, sometimes replaced by one to four bright white spots; sides of abdomen with two to five large conspicuous pure, white spots, widely separated; ventral surface lilac or lavender. Legs long, purple and yellow; tibia with broad alternate bands of dark violet and wax yellow; bristles white. Claws, white, superior claw long, tapering ,rather straight, six toothed; inner edge with two prominent teeth at about equal intervals, two more on both sides near the outer edge, dividing it into thirds; inferior claw half as long as the other, straight, tapering, bearing sub-apically a slender bristle longer than the claw; also a tooth upon a swelling on the inner edge near the base. Furcula almost reaching the head, manubrium, stout, purple; dentes twice as long, slender, pale lilac; each with a long, white bristle on either side and a single extra long ventral sub-apical bristle; mucrones, white, less than one-third the dentes, narrowly elliptical; ventral concavity shallow with distinct serrate edges; apex clearly emarginate, having a median rounded, quadrate notch between two rounded teeth. Ventral sucker with filaments extensible to the length of the antennae. Length, maximum, 3.3 mm. Habits; reported by Folsom from a green house at Cambridge, Mass., upon wet decaying wood, and upon the outside of algae coated flower pots in shaded, moist situations.

This species seems to be quite abundant, and closely resembles *P. marmoratus*, but differs from this species in the character of its claws, having six teeth on its superior claw, while *marmoratus* has but four. It is easily recognized by the broad white head band with sagittal mark, the three median dorsal streaks, and the brilliant white spots on the sides of the abdomen. Types were deposited in the Museum of Comparative Zoology at Cambridge.

13. **Papiruis opalinus** Folsom.

1896. *Papirius opalinus* Folsom.

Prevailing color, orange-rufous or ferruginous. Head; first two antennal segments, anal tubercle, and legs pale orange-ochraceous. Head with a few short bristles on front, vertex almost naked, swollen dorsally. Antennae shorter than the body, from three fourths to one-half as long according to age; basal segment twice as long as broad, naked; second three or four times as long, knotty, and hairy toward the epex; third purple, four or five times the basal in length; distal end knotty, and hairy; terminal segment purple, one and a half times as long as basal, lanceolate with whorls of white hairs. Eye spots black, often quadrate. Body, regular, elongate, oval in dorsal outline; anterior dorsum naked, translucent orange-ochraceous with a broad and median shading of green due to chlorophyll in the stomach; posterior dorsum and sides orange-rufous to dark ferruginous often with a tinge of maroon; posterior dorsum with short, white bristles upon minute brown orange - ochraceous spots; anal tubercle hardly visible from above; ventral surface pale yellow, with three pairs of buff, yellow tubercles; a small round tubercle on either side of the manubrium; a large oval oblique one either side of the middle; a narrow oblique pair anterior to these. Legs slender; femur with short, sparse bristles; tibia pale distally, stout spines at moderate intervals. Claws white, very stout; superior claw of almost uniform width, little curved towards the apex, six toothed; inner edge with a tooth at the middle and another midway between it and the apex; two pairs of lateral teeth similarly placed near the outer edge; inferior claw two-thirds as long as the other, triangular in shape, tipped with a short bristle, inner edge sinuate or straight with a short bristle one-third from its base. Furcula short, reaching to the ventral tube; manubrium sparsely hairy; dentes twice as long, stout, pale orange-rufous with short lateral bristles and several longer ventral bristles at regular intervals; mucrones white, one-fourth the dentes in length, oblong finely serrated beneath, apex rounded. Ventral sucker pale orange-ochraceous, the tube and filaments together one-fourth as long as the antennae. Length, maximum, 1.3 mm. Habitat: reported by Folsom from a green house, Cambridge, Mass. Found in company with *P. vittatus*.

The description was taken from a large number of species, types of which were placed in the Museum of Comparative Zoology.

Explanation of Plates.

Plate XI.

Enlarged drawing of *P. unicolor*, showing the insects in their natural environment.

Plate XII.

P. unicolor: 1, antennae; 2, claw; 3, eye spot; 4, tenaculum; 5, ventral sucker and filaments; 6, spring.